

# **Report for 2002NV9B: Long-Range Water Supply Forecasting for Nevada and the Colorado River Basin**

- Conference Proceedings:
  - Piechota, T.C., 2002. Climate Variability and Water Supply of the Colorado River Basin. Proceedings of the 2002 Conference on Water Resources Planning and Management, Symposium on Managing Extremes: Floods and Droughts, May 19 - 22, 2002, Roanoke, Virginia, American Society of Civil Engineers, Washington D.C.
- Other Publications:
  - Piechota, T.C., 2002. Relevance of Climate Variability, Climate Change, and Long-Range Forecasts to Water Agencies in Southern Nevada and the Colorado River Basin. Final Report to the Southern Nevada Water Authority.

**Report Follows:**

### **Problem and Research Objectives:**

A sufficient water supply in the southwest U.S. is a concern for planners and managers of water systems. The southwest has a limited supply of water and in many cases the demand exceeds the supply. In Nevada, 70% of the total water supply comes from surface water. The surface water generally comes from rivers that are snow-melt driven and experience the highest flow values in the spring and summer time. In Southern Nevada, surface water comes from the Colorado River allotment of 300,000 acre-ft per year. It is estimated that the full Colorado River allotment will be used by the year 2007. In Northern Nevada, the Walker, Carson, Truckee, and Humboldt Rivers are the main source of surface water.

The ongoing research seeks to provide information for better management of water resource systems at the beginning of the water year (October, November, December). This will be accomplished by evaluating the influence of large-scale atmospheric and oceanic processes on streamflow variability. An improved long-range water supply forecasts is the major contribution of this work. **Thus, the overall goal of the research is to develop an improved long-range streamflow forecast for major rivers supplying Nevada with surface water.**

The specific objectives of this research are to:

1. Identify the key oceanic and atmospheric phenomena that influence streamflow variability.
2. Develop long-range exceedance probability forecasts for streams in the Colorado River Basin and Nevada.
3. Compare the skill of long-range forecasts to existing NRCS water supply forecasts.
4. Develop procedures for incorporating an uncertain streamflow forecast into a model for a water resource system.

### **Methodology:**

The research is summarized in four main tasks:

The **first task** in this study investigates the relationship between streamflow and various atmospheric and oceanic parameters. These parameters include those that explain the El Niño – Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO) and global sea surface temperatures (SSTs). The parameters that have the strongest relationship with streamflow will subsequently be used in the long-range streamflow forecast model in Task 2.

The **second task** is to develop a statistical long range streamflow forecast using the predictor variables from the first task. The forecast that will be developed is an exceedance probability forecast that can be used at a given level of risk that a policy makers and/or water resource managers are willing to accept. The statistical streamflow forecast proposed here uses the SOI, PDO, and equatorial Pacific Ocean SSTs as predictors of future streamflow. Also included as a predictor variable, is the observed streamflow up to the time of the forecast. This may prove useful for one to three month forecasts; however, forecasts with longer lead times (e.g., six months) do not have much persistence and observed streamflow is not a good predictor.

The **third task** is to make a comparison of the streamflow forecasts developed in the second task with existing streamflow forecasts developed in the western United States. In many river basins of the western US, spring-summer streamflow is forecast using snowpack data from the previous winter months. The U.S. National Weather Service, in conjunction with the NRCS, supplies the monthly Water Supply Outlook for the Western United States for five months beginning in January of each year. The NRCS report contains the annual streamflow forecast and the spring-summer streamflow forecast for various stream gauging stations throughout the Western U.S. It is not anticipated that the forecasts developed in second task will replace the NRCS forecasts that start in January. Instead, it will compliment and extend the forecasts to the beginning of the water year.

The **fourth task** is to develop procedures for integration of probabilistic streamflow forecast into water resource system models. The PI will work with water agencies to incorporate streamflow forecasts into existing management models. The goal of this task is to incorporate an uncertain streamflow forecast into the operational model of the system that must meet certain constraints (e.g., water demand, reservoir levels, environmental demands).

### **Principal findings and Significance:**

The main activities in Year 1 of the two-year research project have focused on the first research task of evaluating the influence of various atmospheric and oceanic parameters on streamflow variability in the Great Basin (Task 1) and preliminary development of the long-range water supply forecasts (Task 2).

The first analysis determines the strength of the relationship between the climate indicators and streamflow. In this analysis, the average monthly flowrates (cfs) for each USGS station are averaged for each season (JFM, AMJ, JAS, OND). The average seasonal values are then converted to volume (acre-feet) by multiplying the average seasonal flowrates times the duration (time) of the season. Similarly, the average monthly values for the various climate predictors (MEI, PDO, NP, SST1....12) are developed for each season. The timeframe of the above data ranged from 1950 to 1998. This timeframe represents a common period between the climate indicators and the streamflow.

Linear correlations were performed and appropriate confidence levels (90%, 95% and 99%) were determined to provide a measure of statistical significant the results. Noteworthy observations of the correlations analysis are that the ENSO signal (MEI and SST1) is non-existent in each of the five (5) Great Basin stations selected. The ENSO signal is very strong in the Virgin River (Lower Colorado River Basin) but non-existent to weak in each of the three (3) Upper Colorado River Basin stations. The PDO and NP signals is also non-existent in each of the five (5) Great Basin stations selected and non-existent to weak in the four (4) Colorado River Basin stations selected. SST11, an extra tropical region of the South Pacific Ocean, displayed the strongest and most consistent signal at all stations with the exception of the Virgin River, As previously noted, the Virgin River is the only station displaying a strong ENSO signal. SST5, the Gulf of Alaska region of the Pacific Ocean, was the next strongest and most consistent signal followed by SST3.